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(54) **Pedicle screw clamp.**

(57) A pedicle screw clamp (9) comprising two sections (14,16) adapted to form a socket (8) which receives the head (7) of a pedicle screw (12), a hook (20) which holds a spinal support rod (10) at an adjustable distance from the socket (8) and com-

pression means (33) which holds the two sections (14,16) together so that they tightly clamp the head (7) of the pedicle screw (12).

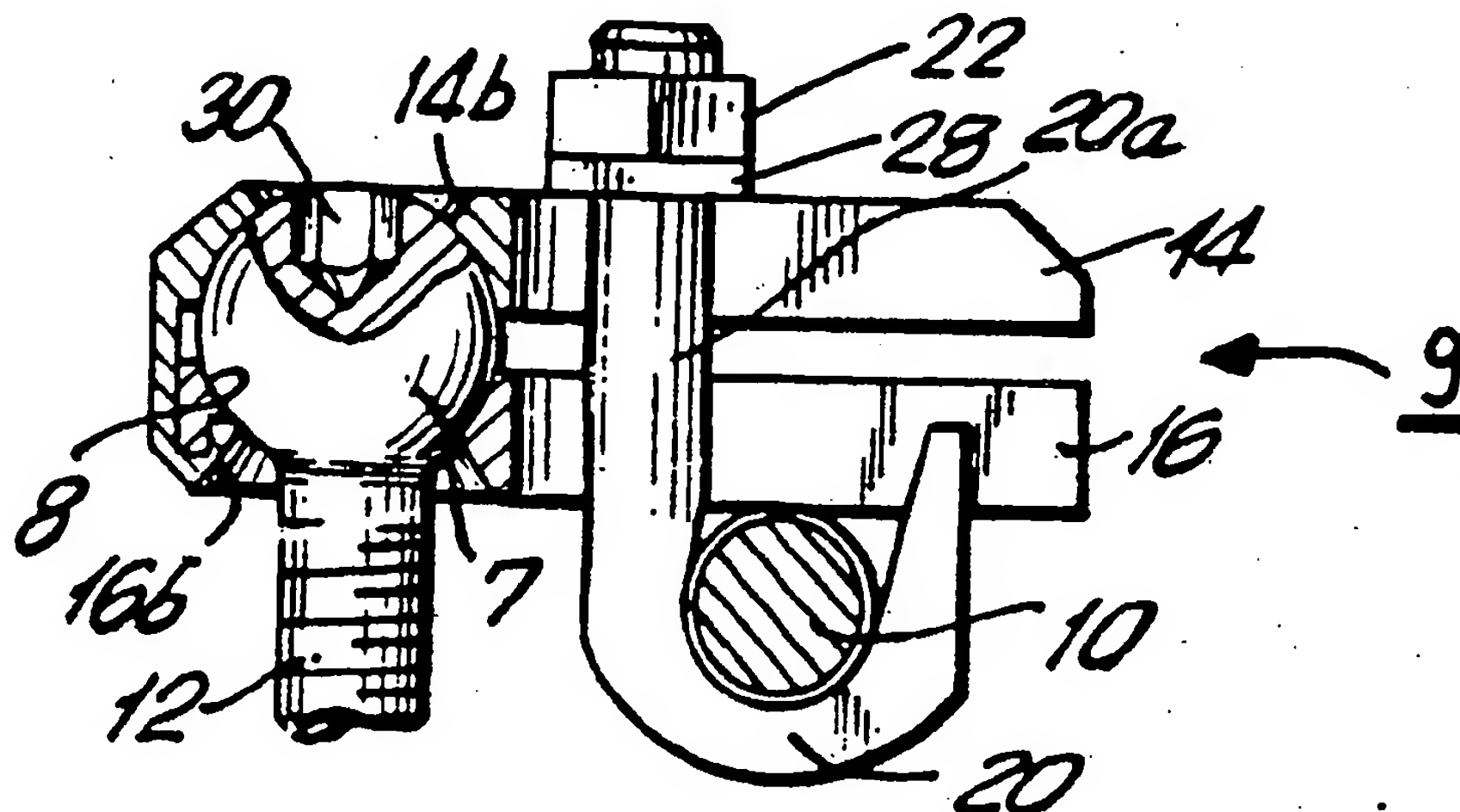


FIG.3

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PEDICLE SCREW CLAMP

Field of the Invention

This invention relates to an osteosynthetic clamp according to the preamble of claim 1 and a fixation assembly according to the preamble of claim 17.

Background of the Invention

Pedicle screws held by clamps in osteosynthetic assemblies are one type of implant used for treating spinal injuries and deformities. In one common treatment the pedicle screws are driven into the pedicles of vertebrae above and below the injured vertebra or vertebrae. A supporting rod is attached to the pedicle screws, for example, by clamps or by threading it through slots in the pedicle screws. The supporting rod holds the spinal column approximately in its desired alignment, thereby relieving pressure on the injured vertebra or vertebrae and permitting it to heal and regain its natural conformation.

One type of pedicle screw is disclosed in U.S. patent application serial no. 163,278, filed March 2, 1988.

As noted, clamps may be used to connect rigidly the part of the pedicle screw protruding from the vertebra to a spinal support rod. In most of these known clamps the pedicle screw and the supporting rod are arranged in the same plane allowing no adjustment to anatomical requirements. In another known type of pedicle screw clamp (according to AT-B 387.710 SULZER) the central axis of the pedicle screw and the central axis of the support rod are located in different planes but still maintained at a fixed, non-adjustable distance, again preventing the surgeon to adapt the clamp to anatomical needs. Furthermore these known pedicle screw clamps do not permit relative angular adjustment of the pedicle screw and the support rod. Thus, current clamps do not allow sufficient adjustment to the specific alignment required by each patient's need.

Summary of the Invention

The invention as claimed is intended to remedy these drawbacks. It solves the problem of how to design an osteosynthetic clamp for attaching a pedicle screw or spinal hook to a spinal support rod with an adjustable distance between the central axis of the pedicle screw and the central axis of the support rod, and at the same time permitting an-

gular adjustment of the central axis of the pedicle screw relative to the central axis of the support rod.

The invention solves the problem with a clamp comprising the features of claim 1 and a fixation assembly comprising the features of claim 14.

In a preferred embodiment the clamp may comprise two sections adapted to receive the head of a pedicle screw, a hook which holds the support rod at an adjustable distance from the pedicle screw and compression means which holds the two sections together so that they tightly clamp the head of the pedicle screw.

In one aspect the invention comprises a clamp having a jaw with upper and lower sections, hinged at one end, said sections being bifurcated to form a slot extending through the sections, a socket formed in the jaw for receiving the head of a pedicle screw and compression means movable relative to said socket for forcing the jaws together, said compression means being adapted to receive a support rod and being operable to urge said rod against the jaw as the jaw sections are forced together.

In another aspect the invention comprises a clamp having a jaw with an upper section and a shorter section, hinged at one end, said upper section being bifurcated to form a slot extending through it, a socket formed in the jaw for receiving the head of a pedicle screw, receiving means which receives a support rod and holds the support rod against the lower surface of the upper section, and compression means, such as a screw extending through the upper and lower sections, which forces them together so as to grasp the head of the pedicle screw.

In another aspect the invention comprises a clamp having front and back section which form a socket for the pedicle screw head, the front section having a bifurcated extension. The clamp further comprises receiving means which receives a support rod and compression means, such as a screw which holds the front and back sections together, grasping the head of the pedicle screw. In another the invention includes a fixation assembly comprising a clamp as described, a pedicle screw having a head shaped to engage the socket and a support rod.

In a further aspect the invention comprises a clamp having a front and a back section forming one single block, the front section having a hollow-cylindrical bore for receiving the support rod and the back section having a slot for adjustably receiving the head region of a pedicle screw.

In still another aspect the invention comprises a clamp having a front and a back section forming

one single element, the front section being bifurcated to form a slot extending through it, the back section forming a spherical head for rotatable fixation in the head region of a pedicle screw.

The advantages offered by the invention are mainly the following:

- ease of manipulation for the surgeon
- adaptability of the system, due to the fact that each pedicle screw may be placed at a different distance from the support rod
- possibility to use not only deformable support rods, but also rigid support rods which offer an increased mechanical strength

The various features of novelty which characterize the invention are pointed out with particularity in the claims annexed to and forming part of this disclosure. For the better understanding of the invention, its operating advantages and specific objects attained by its use, reference should be had to the accompanying drawings and descriptive matter in which are illustrated and described preferred embodiments of the invention.

Brief Description of the Drawings

In the drawings:

Fig. 1 is a side elevational view of a fixation assembly comprising a clamp according to the invention showing the support rod in cross-section;

Fig. 2 is a plan view of the fixation assembly of Fig. 1;

Fig. 3 is a side view of the fixation assembly of Figs. 1 and 2, partially cut away to show the entire head of the pedicle screw;

Fig. 4 is a side view of another embodiment of a fixation assembly comprising a clamp according to the invention;

Fig. 5 is a plan view of the clamp and pedicle screw of Fig. 4;

Fig. 6 is a perspective view of another embodiment of a fixation assembly comprising a clamp according to the invention;

Fig. 7 is a top view of the clamp of Fig. 6.

Fig. 8 is a perspective view of another embodiment of a fixation assembly comprising a clamp according to the invention;

Fig. 9 is a vertical sectional view through the pedicle screw of the assembly of Fig. 8;

Fig. 10 is a vertical sectional view through the clamp of the assembly of Fig. 8;

Fig. 11 is a horizontal sectional view through the clamp of the assembly of Fig. 8;

Fig. 12 is a top view of another embodiment of a partial fixation assembly comprising a clamp according to the invention;

Fig. 13 is plan view of the clamp of the assem-

bly of Fig. 12;

Fig. 14 is a side view of the clamp of the assembly of Fig. 12;

Fig. 15 is a frontal sectional view through the pedicle screw of the clamp of the assembly of Fig. 12;

Fig. 16 is a lateral sectional view through the pedicle screw of the clamp of the assembly of Fig. 12;

Fig. 17 shows the fixation of the clamp of the assembly of Fig. 12 in the head region of the pedicle screw of Fig. 16;

Fig. 18 is a lateral view of the partial assembly of Fig. 17.

Fig. 19 is an exploded view of a preferred embodiment of a fixation assembly according to the invention;

Fig. 20 is plan view of the clamp of the assembly of Fig. 19;

Fig. 21 is a side view of the clamp of the assembly of Fig. 19;

Fig. 22 is a top view of the hook of the assembly of Fig. 19;

Fig. 23 is a side view of the hook of the assembly of Fig. 19; and

Fig. 24 is a perspective view of the assembly of Fig. 19.

Description of the Preferred Embodiments

As shown in Fig. 1, a clamp 9 according to the invention holds a support rod 10, which is preferably threaded, and a pedicle screw 12 in a fixed position, more or less perpendicular to each other. The clamp 1 comprises a jaw 9a having an upper section 14 and a lower section 16, connected to each other by a C-shaped extension 14a of the upper section 14 which engages a flange 16a of the lower section 16 to form a hinge 18. Towards their ends near hinge 18, upper and lower sections 14 and 16 are shaped to form a socket 8 (as represented in Fig. 3) adapted to accommodate the head 7 of the pedicle screw 12. In preferred embodiment of the assembly comprising a clamp according to the invention as shown in Fig. 3, the pedicle screw 12 has an essentially spherical head 7. The upper section 14 of jaw 9a has an aperture 14b providing access to the screw head 7. Lower section 16 has an aperture 16b to accommodate the shaft of the pedicle screw 12.

The surface of the head 7 of pedicle screw 12 may be roughened to provide better grip by the clamp 9. The inner surfaces of the socket 8 which holds the head 7 may also be roughened.

Compression means are provided to press the upper and lower sections 14 and 16 of the jaw 9a together. As shown in Figs. 1 to 3 the compression

means may be a hook 20. As shown in Fig. 2 and 3, the upper and lower sections 14 and 16 are bifurcated to provide a slot 26. The shaft 20a of hook 20 passes through this slot 26. the bight 20b of hook 20 forms a space under lower section 16 adapted to receive a support rod 10. The inner surface of bight 20b may be threaded or otherwise roughened to engage threads or a roughened surface on support rod 10. The lower surface of lower section 16 may be threaded, knurled or otherwise roughened in the area where it contacts support rod 10, in order to engage threads or the like on the support rod 10. The textured surfaces provide for a better grip on the support rod 10, which must be held firmly in place. The upper surface of upper section 14 has toothed areas 24 along the sides of through slot 26. A small retaining plate 28 with teeth 28a on one surface rests on top of and bridges the toothed areas 24, with the two sets of teeth interlocking. The distance between the axis of shaft 20a of hook 20 and the central axis of pedicle screw 12 can be varied by moving the small toothed plate 28 along the length of through slot 26. Nut 22 is threaded on the hook shaft 20a on top of plate 28. Tightening nut 22 locks plate 28 and hook 20 into the desired place along through slot 26.

In using the device according to the invention, the pedicle screw 12 is first run through the aperture 16b in the lower jaw section 16 and inserted into the bone, using the hexagonal socket 30 in the head 7 of the pedicle screw 12 to receive a suitable tool. The upper section 14 is then engaged with lower section 16 to form a jaw 9a. Hook 20 is loosely inserted in through slot 26 and the support rod 10 inserted in the bight 20b of the hook 20, the hook 20 being moved along the through slot 26 to the desired position. When pedicle screw 12 and support rod 10 are at the optimum distance from one another and at the proper angle, nut 22 is turned down on the shaft 20a of the hook 20, forcing the jaw sections 14 and 16 together to clamp the head 7 of the pedicle screw 12 in this socket 8 and press support rod 10 firmly against lower section 16. The leverage provided by the jaw construction 9a enables the pedicle screw 12 to be tightly fixed in its selected position relation to the support rod 10.

Another embodiment of the invention is shown in Figs. 4 and 5. Clamp 35 comprises a bifurcated upper section 36 and a lower section 37, connected to each other by a hinge 38 with a pin 39. On one side of pedicle screw 12 opposite the hinge 38 are two threaded screws 40. These screws hold upper section 36 and lower section 37 together, thus locking the head 7 of pedicle screw 12 in place. Fig. 5 shows two screws 40, but in alternative embodiment, a single screw 40 may be used.

Lower section 37 is shorter than upper section 36, as shown in Fig. 4. A hook 20 as described in connection with Figs. 11 - 3 passes through the slot 26 formed by the bifurcation of upper section 36 and holds a support rod 10 against the lower surface of upper section 36. It should be evident that the configuration of the toothed upper surface 24, small retaining plate 28 and nut 22 described in connection with Figs. 1 - 3 are applicable to this embodiment as well.

The manner of use of the embodiment according to Figs. 4 and 5 is parallel to that according to Figs. 1 - 3.

Another embodiment of the invention is shown in Figs. 6 and 7. In this embodiment the head 7 of the pedicle screw 12 instead of being clamped by two hinged elements is held between two sections of a block which are joined by screws or bolts. Referring to Fig. 6, the clamp in this embodiment comprises a block 50 having a front section 44 and a back section 46. Front section 44 has a bifurcated extension 45 which forms a slot 26. As shown in Fig. 6 a hook 20, support rod 10, toothed upper surface 24, small toothed plate 28 and nut 22 are provided as described above in connection with Figs. 1 - 5. Front section 44 has two screw holes 49 through it. As shown in Fig. 6, these screw holes 49 are at an angle of about 45° to the top surface of the clamp or the axis of the pedicle screw 12 to be retained in the clamp. These screw holes 49 continue into back section 46 at the same angle. In a preferred embodiment, only the parts of screw holes 49 which are in the back section 46 are threaded, while screws 47 may be partially or wholly threaded. Front and back sections 44 and 46 are shaped to form a socket 48 which accommodates the head 7 of a pedicle screw 12. Engagement of screws 47 into the threaded holes in back section 46 forces the back section 46 against front section 44 and secures pedicle screw 12 in its desired position.

When using this embodiment of the invention, the pedicle screw 12 is first inserted into the bone. Front section 44 is placed on the front of the screw head 7, with a hook 20 inserted in slot 26 and the support rod 10 held in the bight of the hook 20. When the pedicle screw 12 and the support rod 10 are adjusted to the optimum distance and angle, back section 46 is placed on the back of the pedicle screw head 7. Screws 47 are inserted into screw holes 49 and tightened. In the embodiment shown in Fig. 6, screws 47 have hexagonal holes in their heads to receive a tool for tightening them. The 45° degree angles make it easier for the surgeon to reach the screws 47. In an alternative configuration (not shown) the screws 47 are put in straight from back section 46 to front section 44, with the axis of the screw holes 49 parallel to the

bifurcated extension 45 or generally perpendicular to the axis of the pedicle screw 12.

The ends of extension 45 may be flanged as shown in Fig. 6, or they may have a simple rectangular cross-section, on any of the embodiments of the invention.

Another embodiment of the invention is shown in Figs. 8 and 11. In this embodiment the clamp 60 has a front section 54 and a back section 56 forming one single block, the front section 54 having a hollow-cylindrical bore 53 for receiving the support rod 10 and the back section 56 having a slot 51 for adjustably receiving the head region 57 of a pedicle screw 52.

The bore 53 can either have a smooth surface or preferably a structured surface (threads or longitudinal grooves), at least on the side opposite screw hole 61, said structured surface being similar to corresponding structures on the surface of support rod 10. Upon fastening of screw 59 support rod 10 is pressed against the structured surface of bore 53 thereby producing a firm fixation.

The head region 57 of the pedicle screw 52 is designed as a threaded cylinder insertable into the longitudinal slot 51 of the back section 56 and which can be adjustably secured against back section 56 of the clamp 60 by means of the nut 58. For the ease of insertion of the pedicle screw 52 the head region 57 is provided with a central hexagonal bore 62.

Fixation of the support rod 10 occurs by means of the screw 59 in the screw hole 61 of the front section 54 of the clamp 60, allowing the releaseable fixation - against longitudinal and rotational movement - of the support rod 10 with respect to the clamp 60.

Another embodiment of the invention is shown in Figs. 12 and 18. In this embodiment the clamp 70 is similar to clamp 35 of Fig. 5; the difference being that the head of the pedicle screw is not clamped by suitable elements of the clamp but is incorporated in the clamp 70 itself for being fixed into the head of the pedicle screw.

Clamp 70 therefore has a front section 64 and a back section 66 forming one single element, the front section 64 being bifurcated - in the same way as clamp 35 of Fig. 5 - to form a slot 71 extending through it, the back section 66 forming a spherical head for rotatable fixation in the head region 77 of a pedicle screw 72.

The head region 77 of the pedicle screw 72 has a frontally accessible socket 73 into which the spherical head of the back section 66 of the clamp 70 can be inserted and secured by means of the central screw 74. Central screw 74 can be tightened by means of the central hexagonal bore 75 into a corresponding screw hole 76 in the head region 77. Fixation of the spherical head 66 in the

socket 73 occurs by means of two anchoring points incorporated in the lower half of the head region 77 and third anchoring point 79 incorporated in the lower surface of the central screw 74. Socket 73 has circular back opening 81 and a circular front opening 82, said back opening 81 having a diameter inferior to the diameter of the spherical head 66 and said front opening 82 having a diameter superior to the diameter of the spherical head 66. By this construction the spherical head 66 can be safely fixed in the socket 73 - as shown in Fig. 17 - by means of the points 78,79 against the annular rim 83 of back opening 81.

As shown in Fig. 18 this embodiment of the invention allows the angular adjustment of the clamp 70 with relation to the pedicle screw 72.

Fixation of the support rod 10 is achieved in the same way as for clamp 35 of Fig. 4 by means of suitable hook 20 as described in connection with Figs. 1 - 3 which passes through the slot 71 formed by the bifurcation of front section 64 and holds a support rod 10 against its lower surface. It should be evident that the configuration of the toothed upper surface 24, small retaining plate 28 and nut 22 described in connection with Figs. 1 - 3 are applicable to this embodiment as well.

Still another embodiment of the invention is shown in Figs. 19 to 24. In this embodiment clamp 90 is somewhat similar to clamp 70 of Fig. 13; the difference being that the bifurcated front section 84 is not connected to a spherical head but to a longitudinal cylindrical section which is provided with threads. Clamp 90 therefore has a front section 84 and a back section 86 forming one single element, the front section 84 being bifurcated - in the same way as clamp 70 of Fig. 13 - to form a slot 91 extending through it, the back section 86 forming a longitudinal cylindrical section 86 which is provided with threads for fixation in the head region 97 of a pedicle screw 92.

The head region 97 of pedicle screw 92 is also bifurcated forming a canal 85 for receiving the back section 86 of clamp 90, which can be secured by means of the screw cap 93. Screw cap 93 has preferably a (not-represented) coaxial inner cylindrical portion with reduced diameter which is threaded at its surface for engagement into the inner thread 87 of the bifurcated head region 97 of the pedicle screw 92. Screw cap 93 may be fastened to the head region 97 by means of a hexagonal screw driver engaging with the hexagonal bore 88 of screw cap 93.

Fixation of the support rod 10 is achieved in a similar way as for clamp 35 of Fig. 4 by means of a suitable hook 94 as described in connection with Figs. 1 - 3. The hook 94 has a threaded portion 95 in the inner concavity of its curved portion 99 and an outer threaded portion 98 on its straight portion.

100. The straight portion 100 of the hook 94 passes through the slot 91 formed by the bifurcation of front section 84 and upon fixation with the nut 96 on the threaded portion 98 holds a support rod 10 against its lower threaded surface 95. It should be evident that the configuration of the toothed upper surface 24, small retaining plate 28 and nut 22 described in connection with Figs. 1 - 3 are applicable to this embodiment as well.

The various surfaces described in connection with Figs. 1 - 3, as being roughened to provide better grip may of course be employed in the other embodiments too.

From a consideration of the foregoing description it will be evident that a clamp according to the invention permits movement of the support rod relative to the pedicle screw. The surgeon can therefore regulate the horizontal distance between the pedicle screw and the support rod. Because the spherical head of the pedicle screw may be tilted in its socket the angle between the pedicle screw and the support rod may also be adjusted. Thus the clamp according to the invention permits the surgeon to adjust each pedicle screw to the specific configuration required by a particular patient.

Although the invention has been described as applied to a pedicle screw, it is clearly also applicable to other similar devices such as spinal hooks.

Claims

1. An osteosynthetic clamp (9;35) for attaching a pedicle screw (12) or spinal hook to a spinal support rod (10) wherein the central axis (6) of said pedicle screw (12) or spinal hook and the central axis (5) of said spinal support rod (10) are located in different planes, characterised in that means are provided allowing the adjustable clamping of said pedicle screw (12) or spinal hook with respect to said spinal support rod (10) such that the relative position of the said two axis (5,6) in said planes is adjustable.

2. Clamp according to claim 1, characterised in that it comprises:

a first section (14) and a second section (16), at least one of said section (14) being bifurcated to form a through slot (26),

a socket (8) formed in said first and second sections (14,16) for receiving the head (7) of a pedicle screw (12), receiving means (4) adapted to receive a support rod (10), said receiving means (4) being movable relative to said socket (8), and

compression means (22) for forcing said two sections (14,16) together to grasp the head (7) of a pedicle screw (12) lodged in said socket (8).

3. Clamp according to claim 1, characterised in that it comprises:

a jaw having an upper section (36) and a lower section (37), said lower section being preferably shorter than said upper section (36), hingedly (38,39) connected to each other, preferably at one of their ends, one of said sections (36,37) at least being bifurcated to form a slot (26) extending through at least one of said sections (36,37),

a socket (8) formed in said jaw for receiving the head (7) of a pedicle screw (12),

first compression means (22) movable relative to said socket (8), said compression means (22) being adapted to receive a support rod (10) and to urge said support rod (10) against the upper section (37) of said jaw; and

second compression means (40), for forcing the sections (36,37) of said jaw together to grasp the head (7) of a pedicle screw (12) lodged in said socket (8).

4. Clamp according to claim 1, characterised in that it comprises:

a front section (44) and a back section (46) forming a block (50), said front section (44) being provided with a through slot (26), preferably forming a bifurcation of said front section (44),

a socket (48) formed in said front and back sections (44,46) for receiving the head (7) of a pedicle screw (12), receiving means (4) adapted to receive a support rod (10), said receiving means (4) being movable relative to said socket (8), and

compression means comprising one or more screws (47) adapted to fit into one or more screw holes (49) extending from one section (44) into the other section (46) for forcing said two sections (44,46) together to grasp the head (7) of a pedicle screw (12) lodged in said socket (8).

5. Clamp according to claim 1, characterised in that it comprises:

a front section (64) and a back section (66), said front section (64) being bifurcated to form a through slot (71) and said back section (66) being of spherical shape for fixation into the head region (77) of a pedicle screw (72), receiving means (4) adapted to receive a support rod (10), said receiving means (4) being movable relative to said front section (64), and

compression means (74) for fixing said spherical back section (66) within the head region (77) of a pedicle screw (72).

6. Claim according to claim 2 or 5, characterised in that the receiving means (4) comprises a hook (20) having a bight (20b) and a shaft (20a) extending through the slot (26) in said section or sections (14,16), said bight (20b) being adapted to receive a support rod (10).

7. Clamp according to one of the claims 2 to 5, characterised in that it comprises further a retaining

plate (28) on the upper surface of one section (14), said retaining plate (28) having a hole to receive the shaft (20a) of the hook (20).

8. Clamp according to claim 7, characterised in that it comprises further a nut (22) on the end of the shaft (20a) of the hook (20) for holding the retaining plate (28) against the upper surface of one section (14).

9. Clamp according to one of the claims 6 to 8, characterised in that the retaining plate (28) and the upper surface of one section (14) have toothed areas (28a,24) adapted to engage one another.

10. Clamp according to one of the claims 2 to 9, characterised in that the socket (8) is adapted to receive a spherical-headed pedicle screw (12).

11. Clamp according to one of the claims 2 to 10, characterised in that the socket (8) has roughened surfaces.

12. Clamp according to one of the claims 6 to 11, characterised in that a surface of the bight (20b) of the hook (20) is threaded for engagement with threads of a support rod (10).

13. Clamp according to one of the claims 2 to 12, characterised in that one of said sections (16;46) has a roughened surface for contact with a support rod (10).

14. Clamp according to claim 4, characterised in that said screw holes (49) extend from the front section (44) into the back section (46) at an angle of approximately 45° to the axis (6) of the pedicle screw (12).

15. Clamp according to claim 1, characterised in that it comprises:

a front section (54) and a back section (56) forming one single block (60), the front section (54) having a hollow-cylindrical bore (53) for receiving a support rod (10) and the back section (56) having a slot (51) for adjustably receiving the head region (57) of a pedicle screw (52),

compression means (58) for fixing said head region (57) of said pedicle screw (52) inserted in said slot (51) relative to said back section (56), and compression means (59,61) for fixing said support rod (10) inserted in said bore (53) relative to said front section (54).

16. Clamp according to claim 1, characterised in that it comprises:

a front section (84) and a back section (86) forming one single element, the front section 84 being provided with a through slot (91), preferably forming a bifurcation of said front section (84), and said back section (86) being of longitudinal cylindrical shape for fixation into the head region (87) of a pedicle screw (92),

receiving means (94) adapted to receive a support rod (10), compression means (93) for fixing said longitudinal cylindrical back section (86) within the head region (87) of a pedicle screw (92); and

compression means (96) for fixing said support rod (10) inserted in said receiving means (94) relative to said front section (84).

17. Fixation assembly with a clamp (9;35) according to one of the claims 1 to 16, characterised in that it comprises further a support rod (10); and a pedicle screw (12).

18. Assembly according to claim 17 characterised in that the pedicle screw (12) has a spherical head (7).

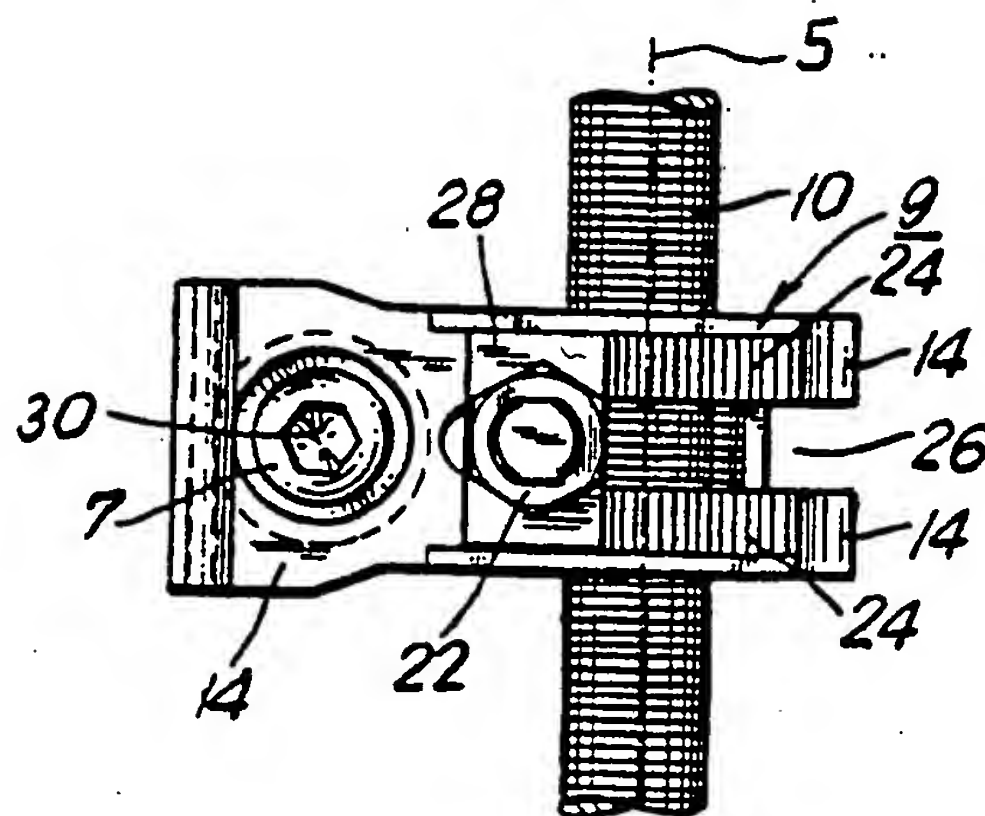


FIG. 2

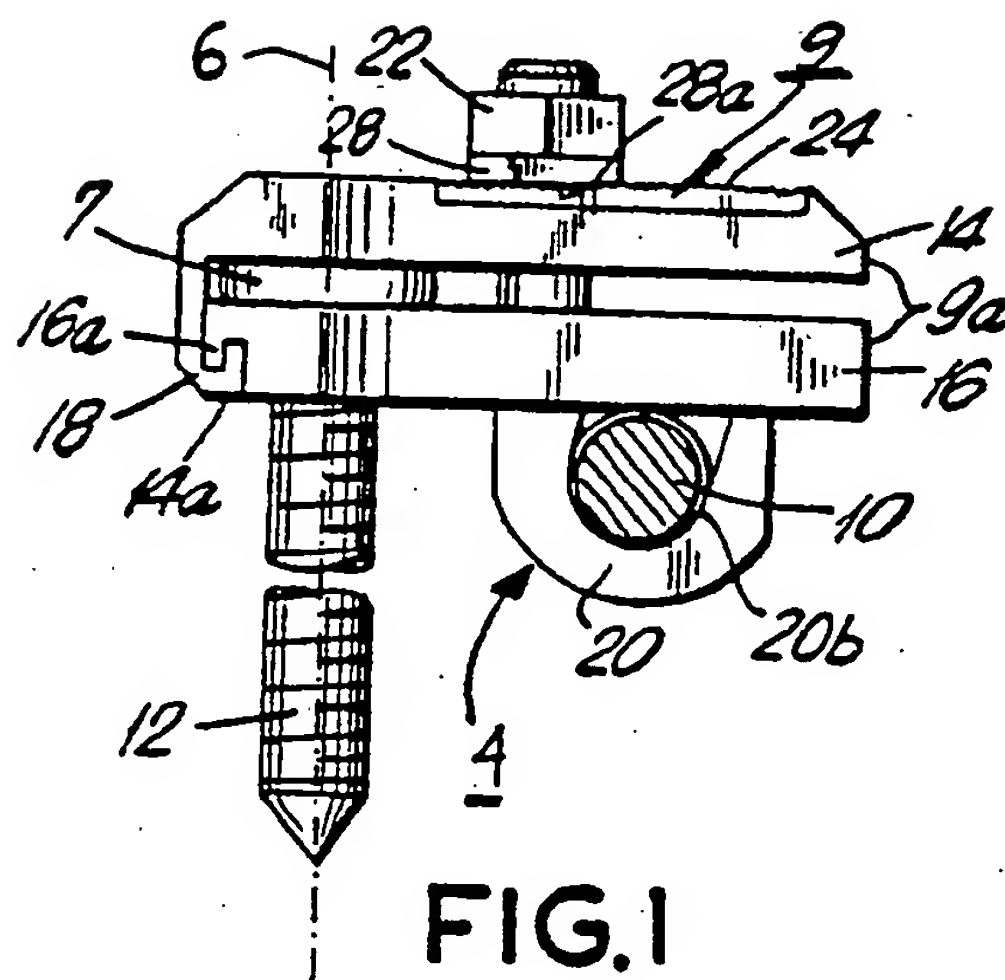


FIG.1

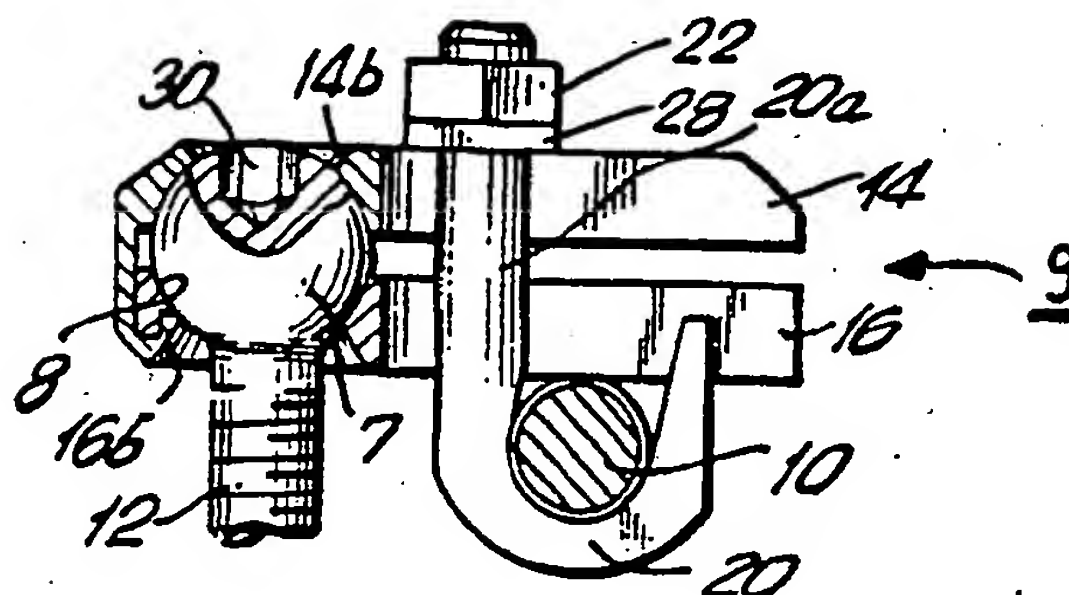
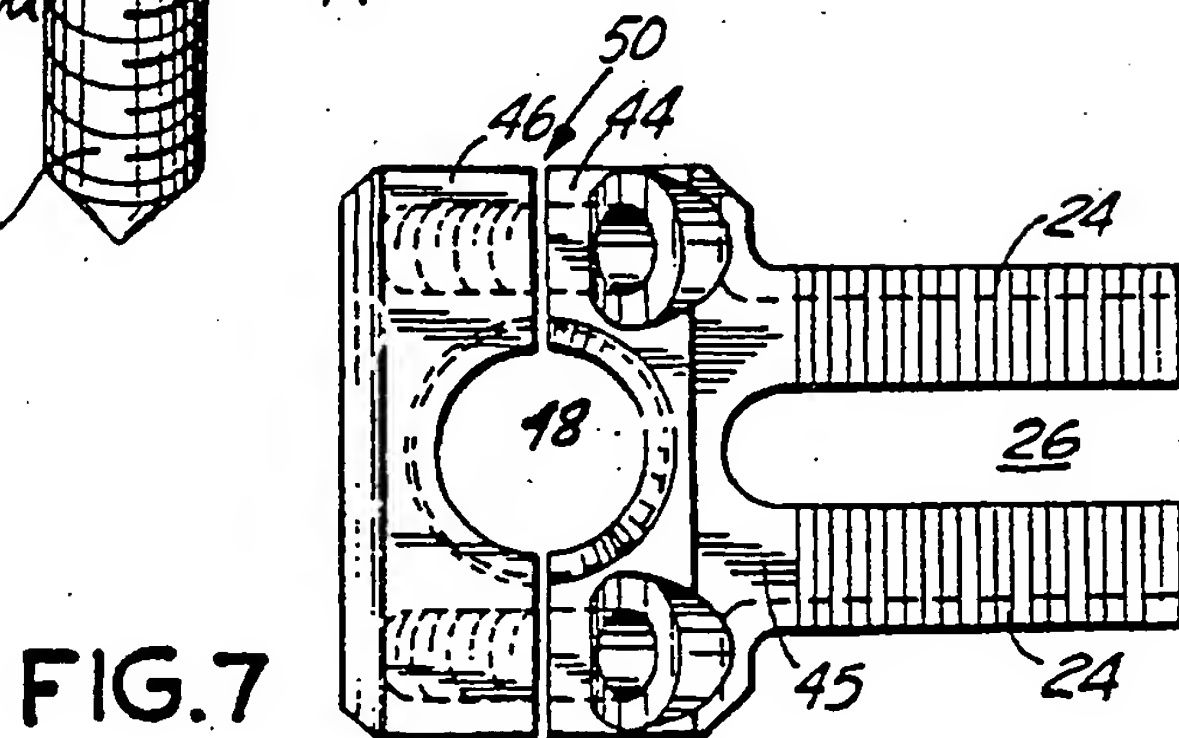
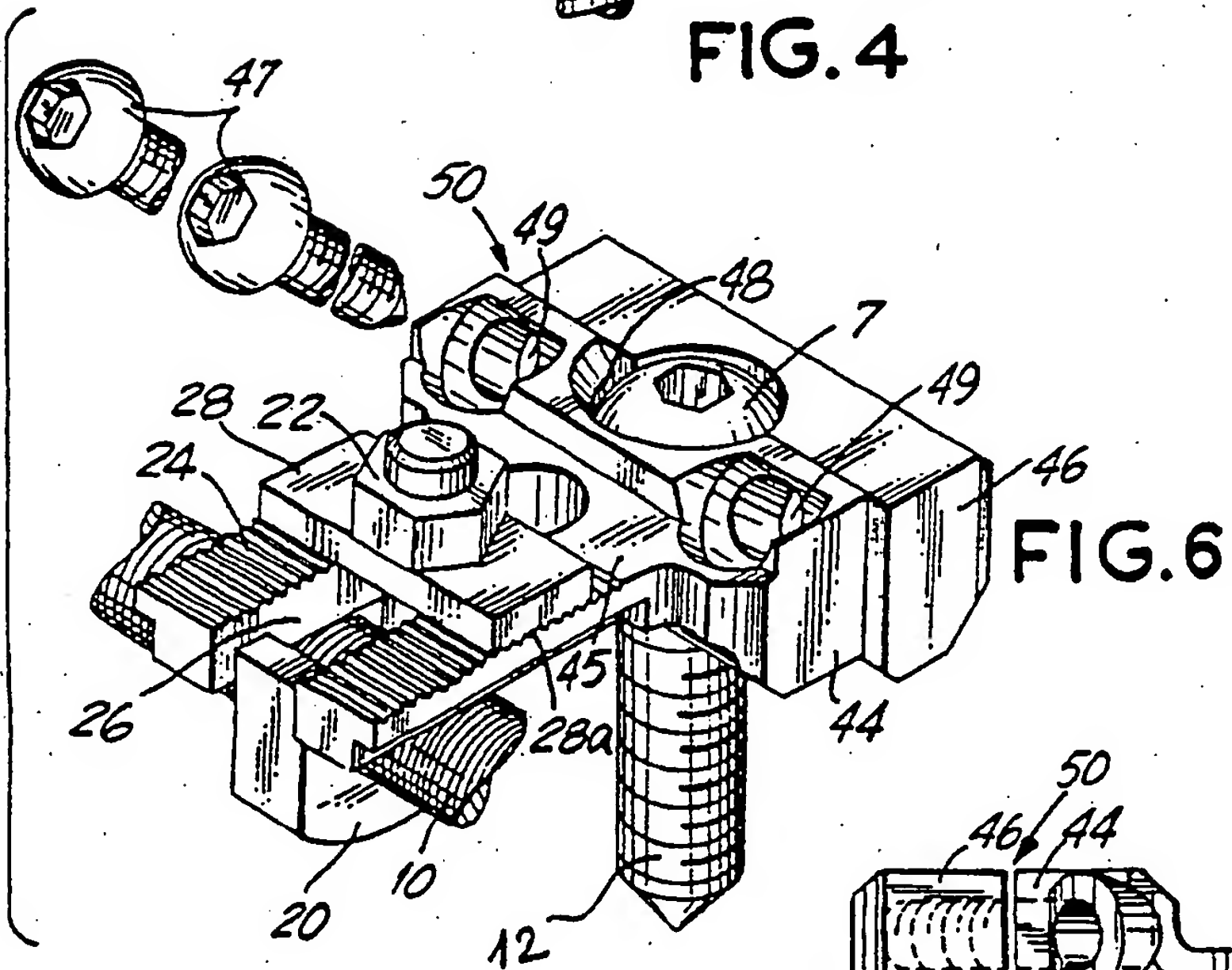
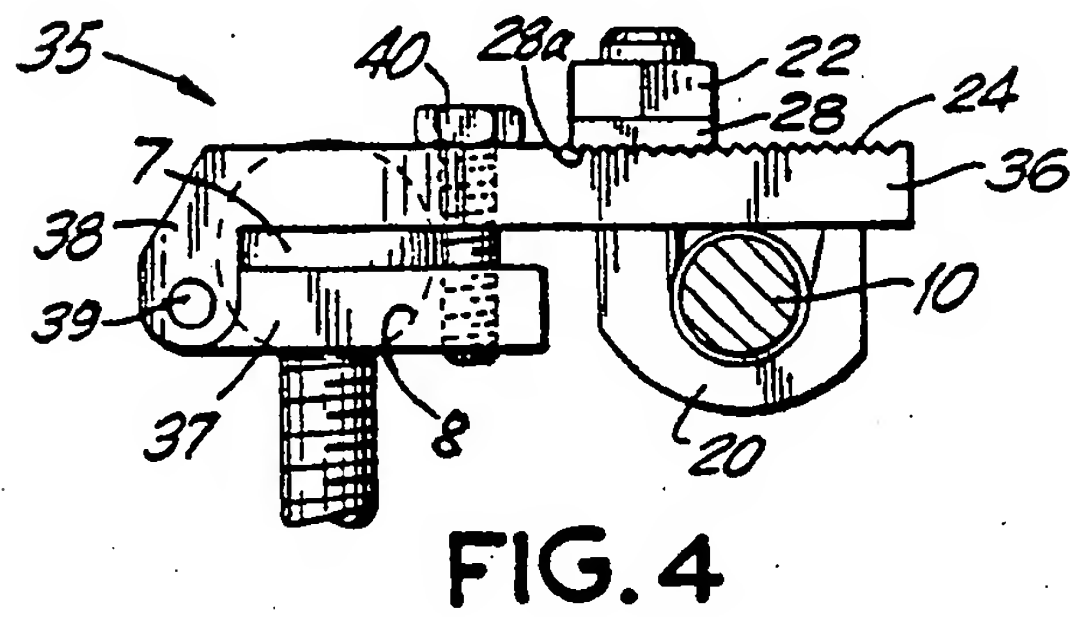
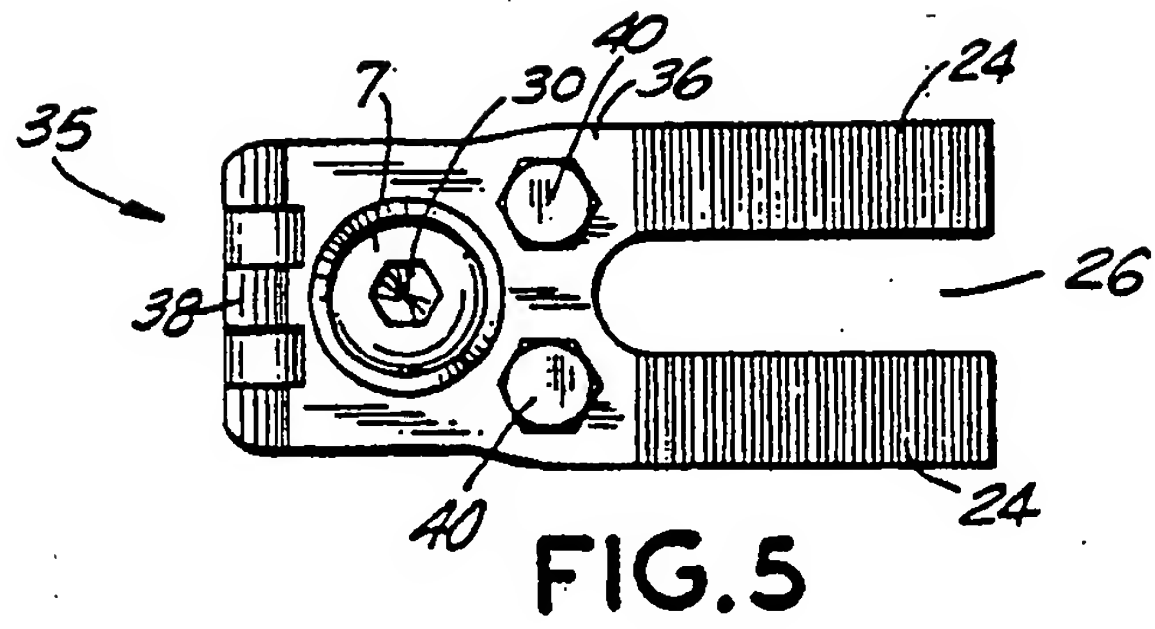


FIG.3



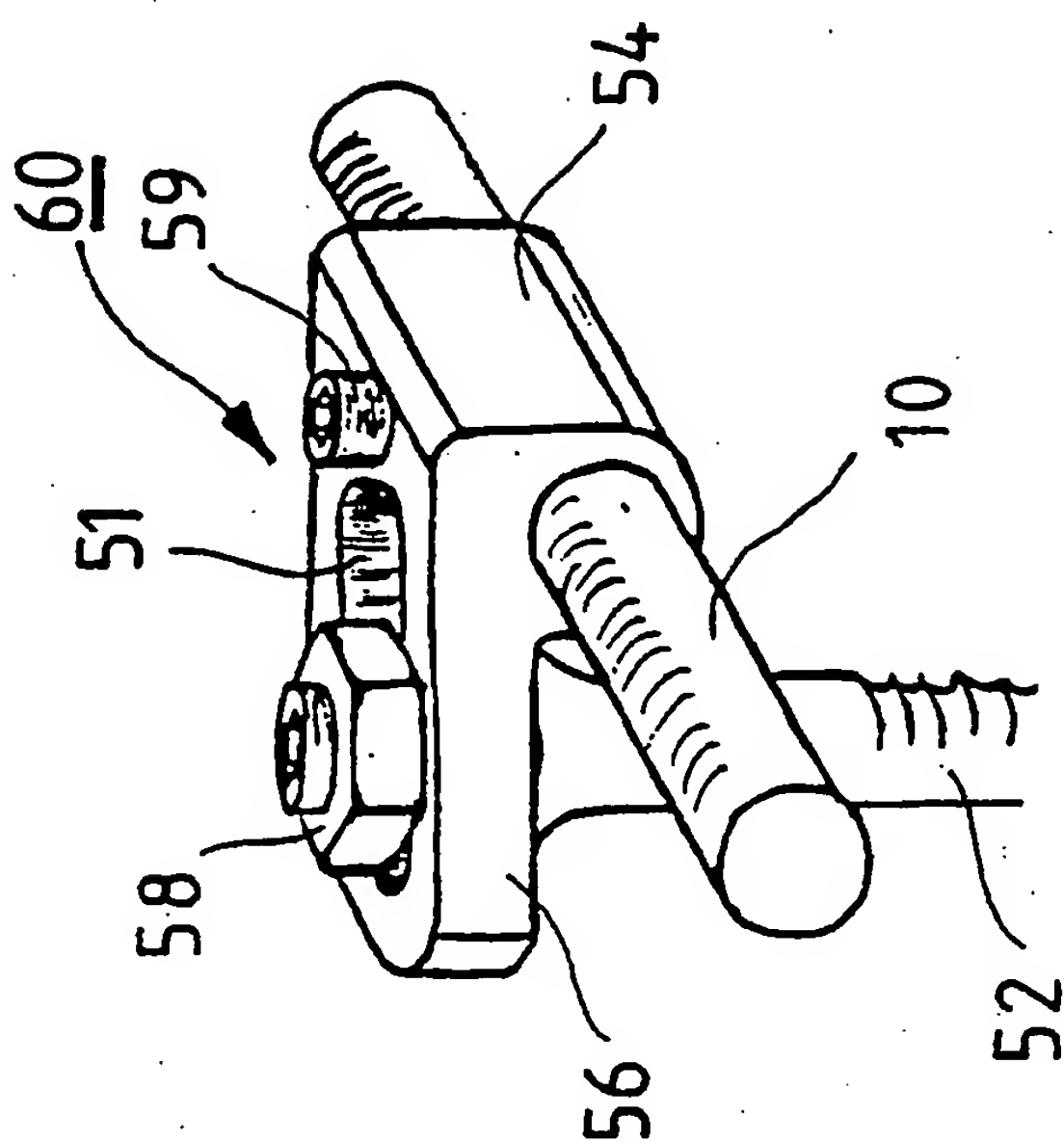


Fig. 8.

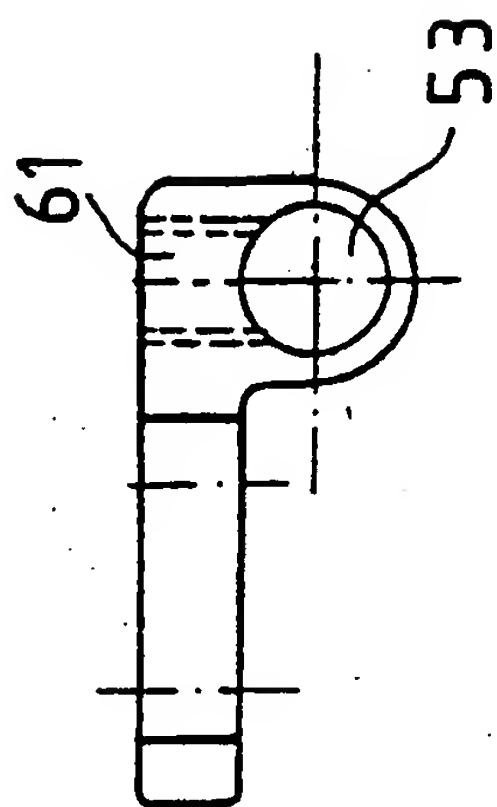


Fig. 10

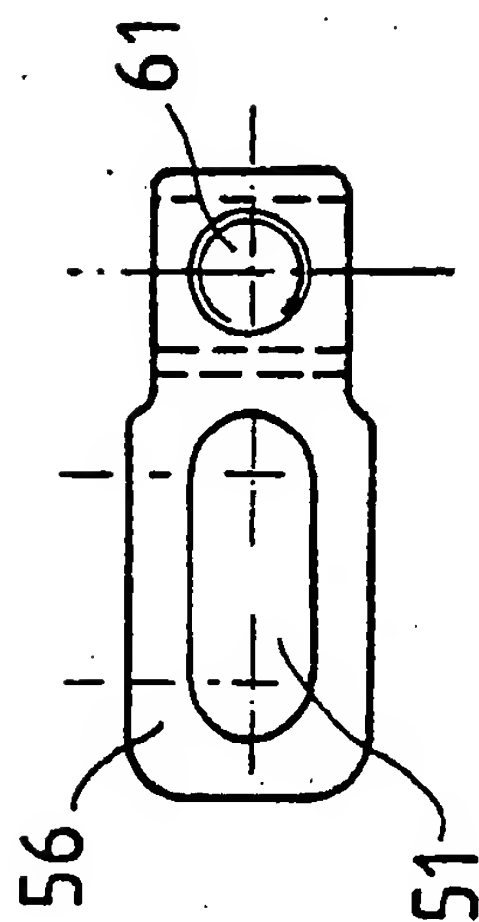


Fig. 11

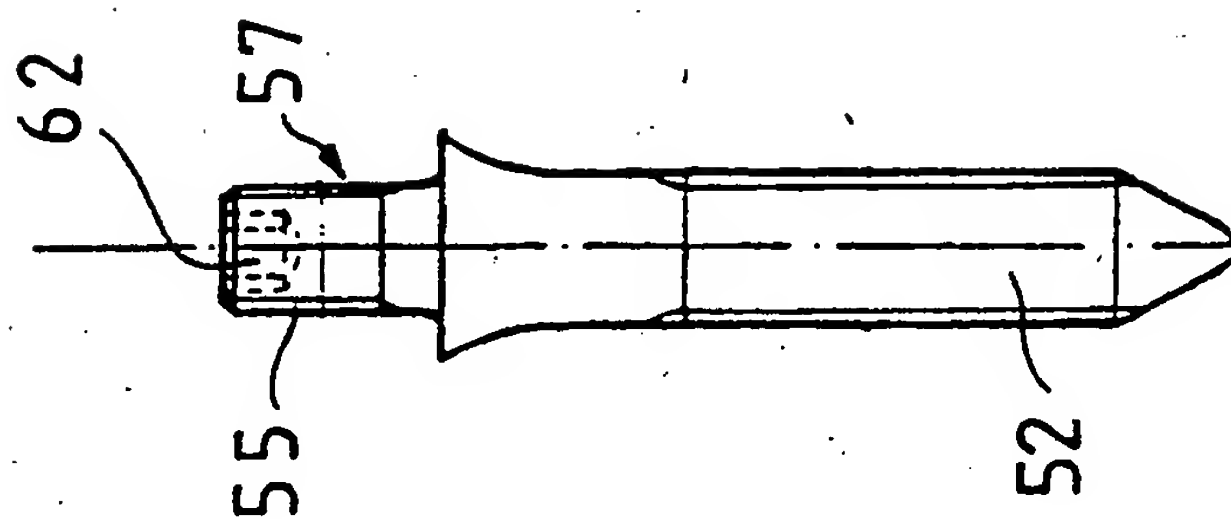


Fig. 9

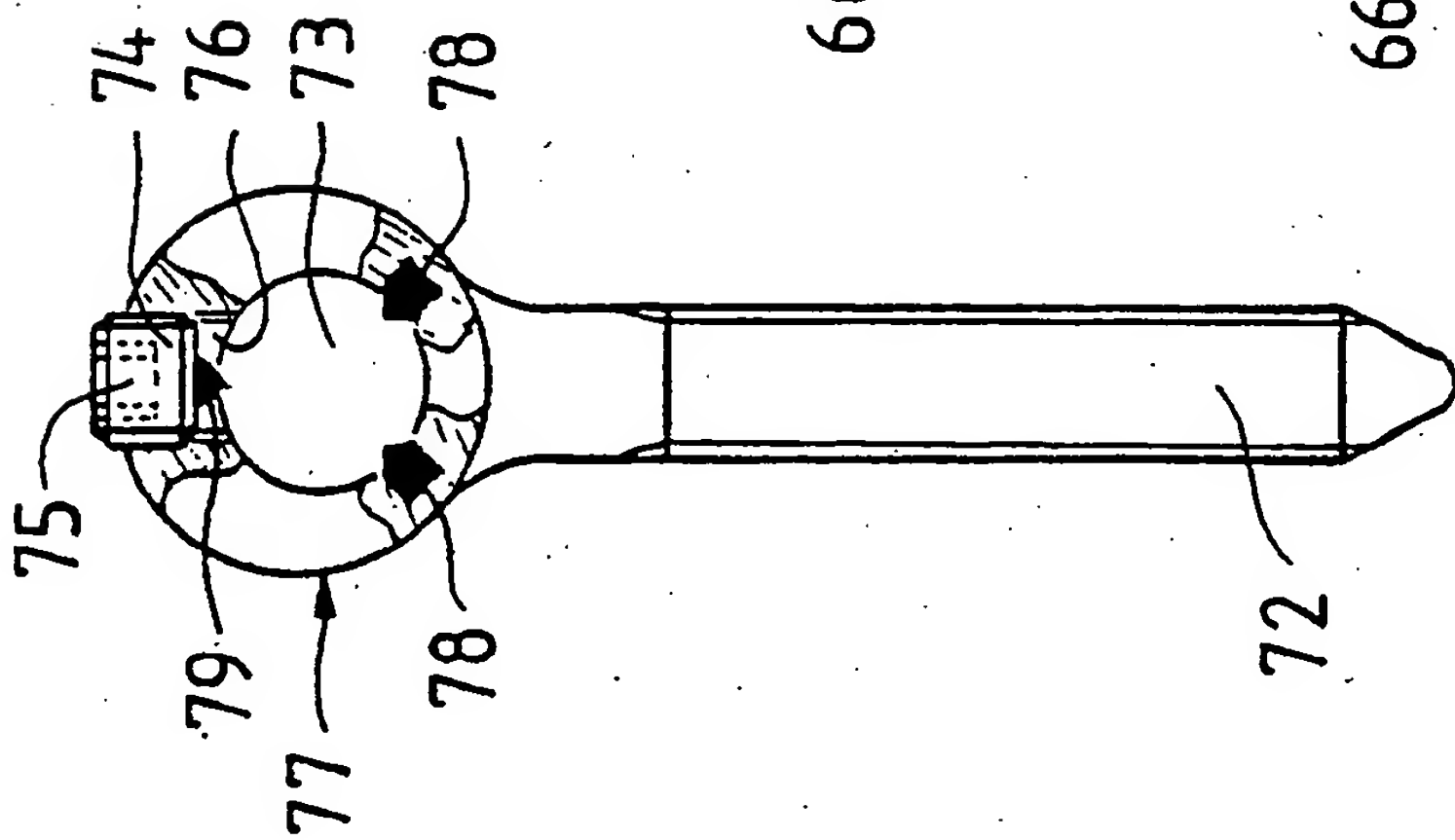


Fig. 14

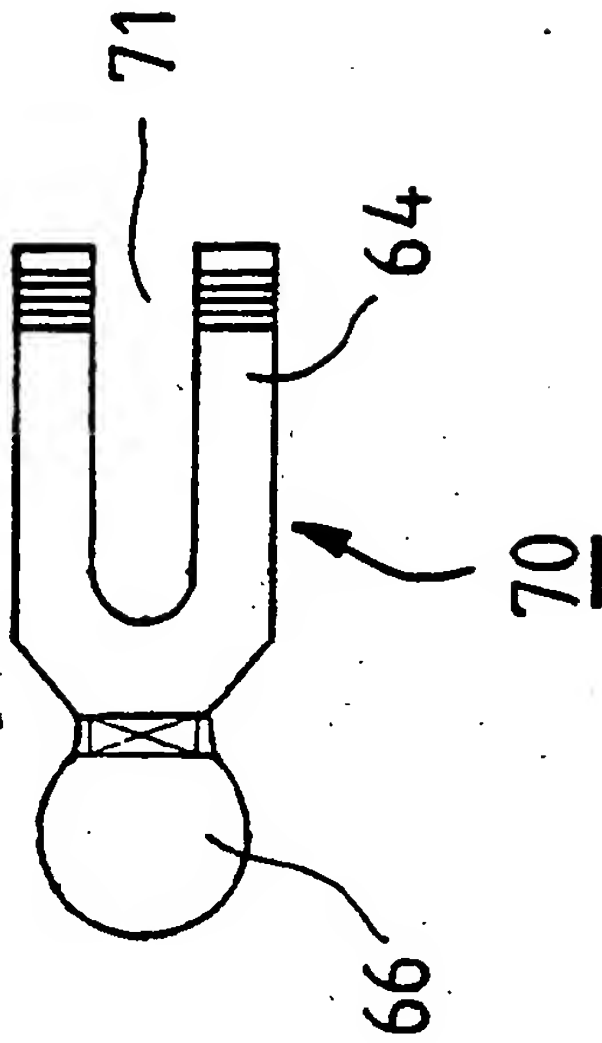
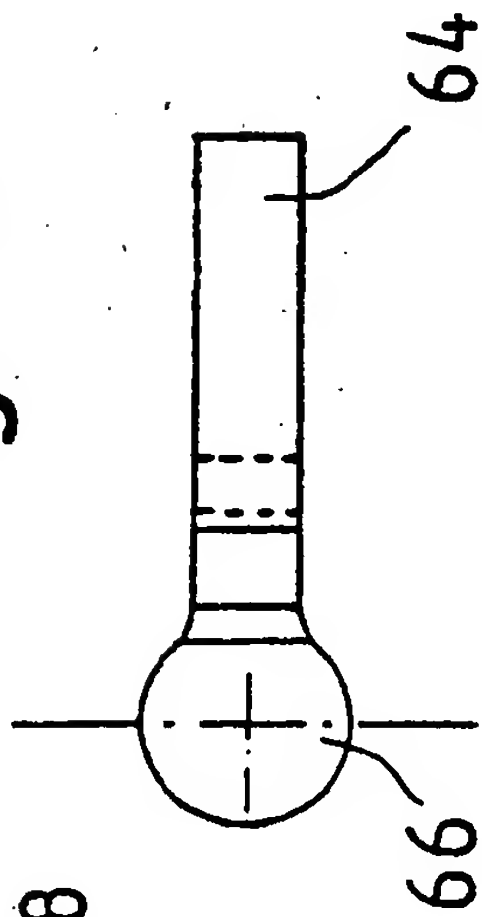


Fig. 15

Fig. 13

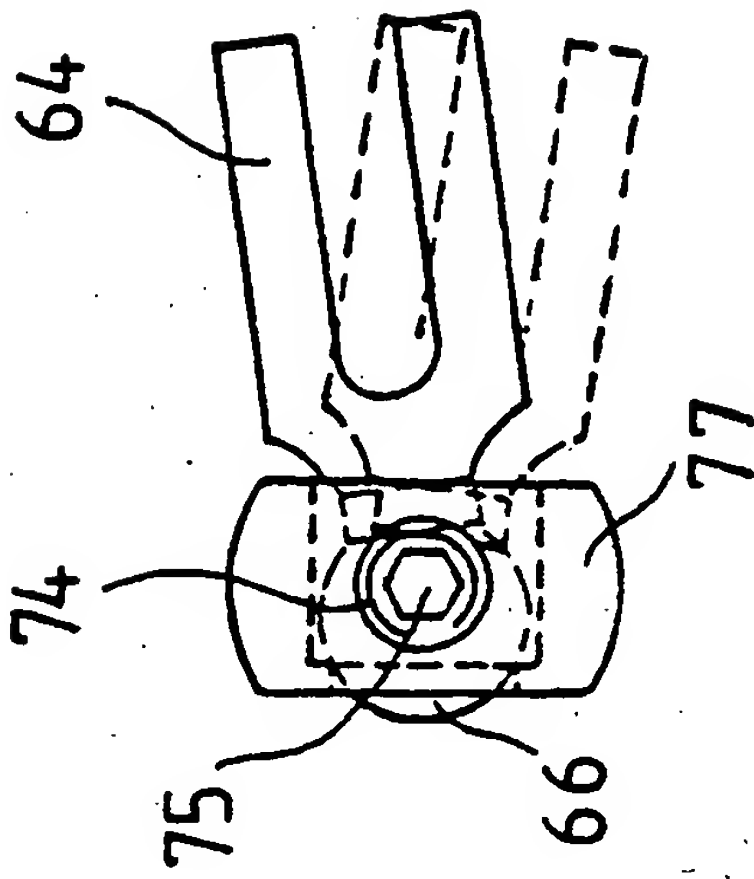


Fig. 12

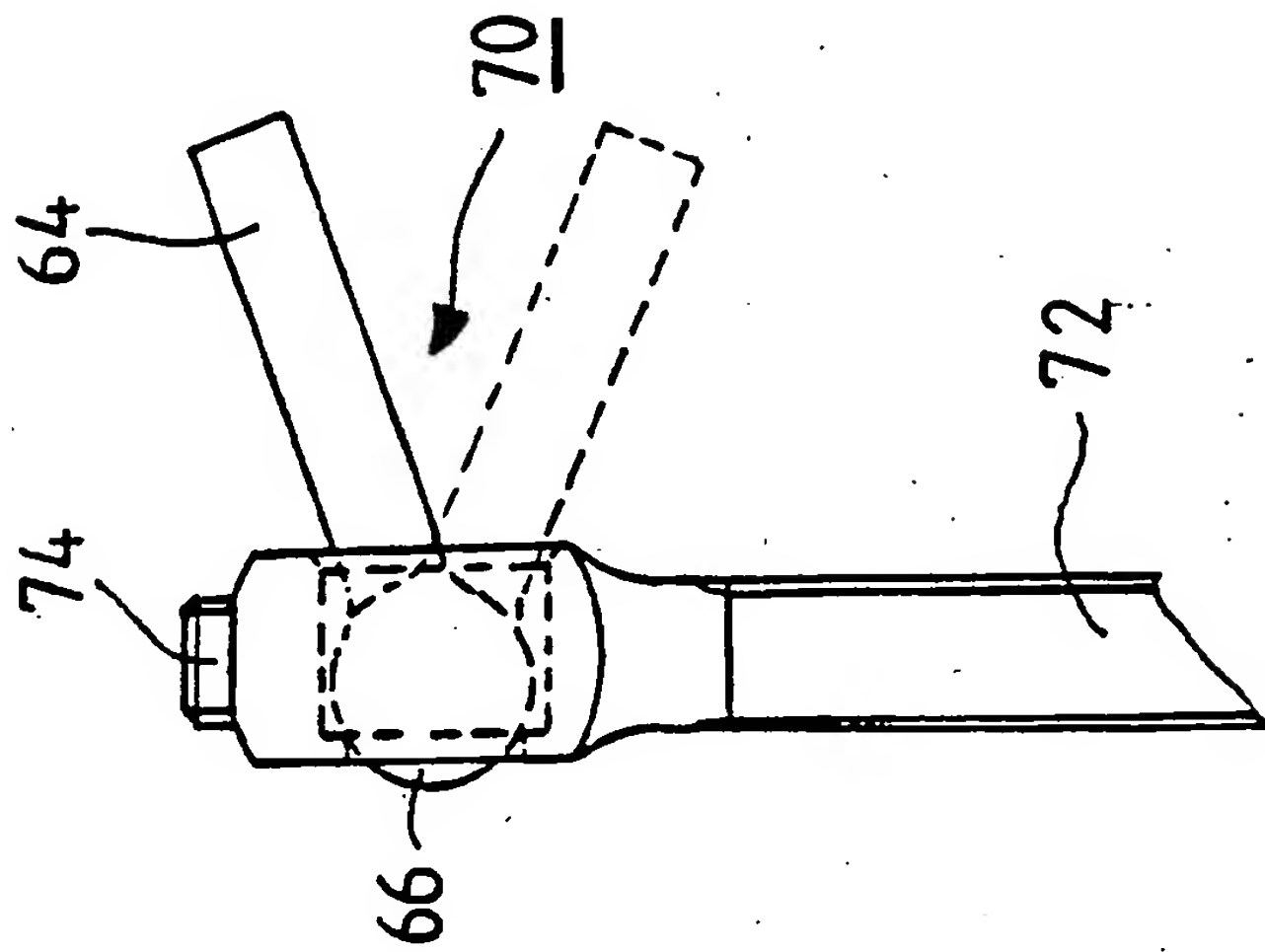


Fig. 18

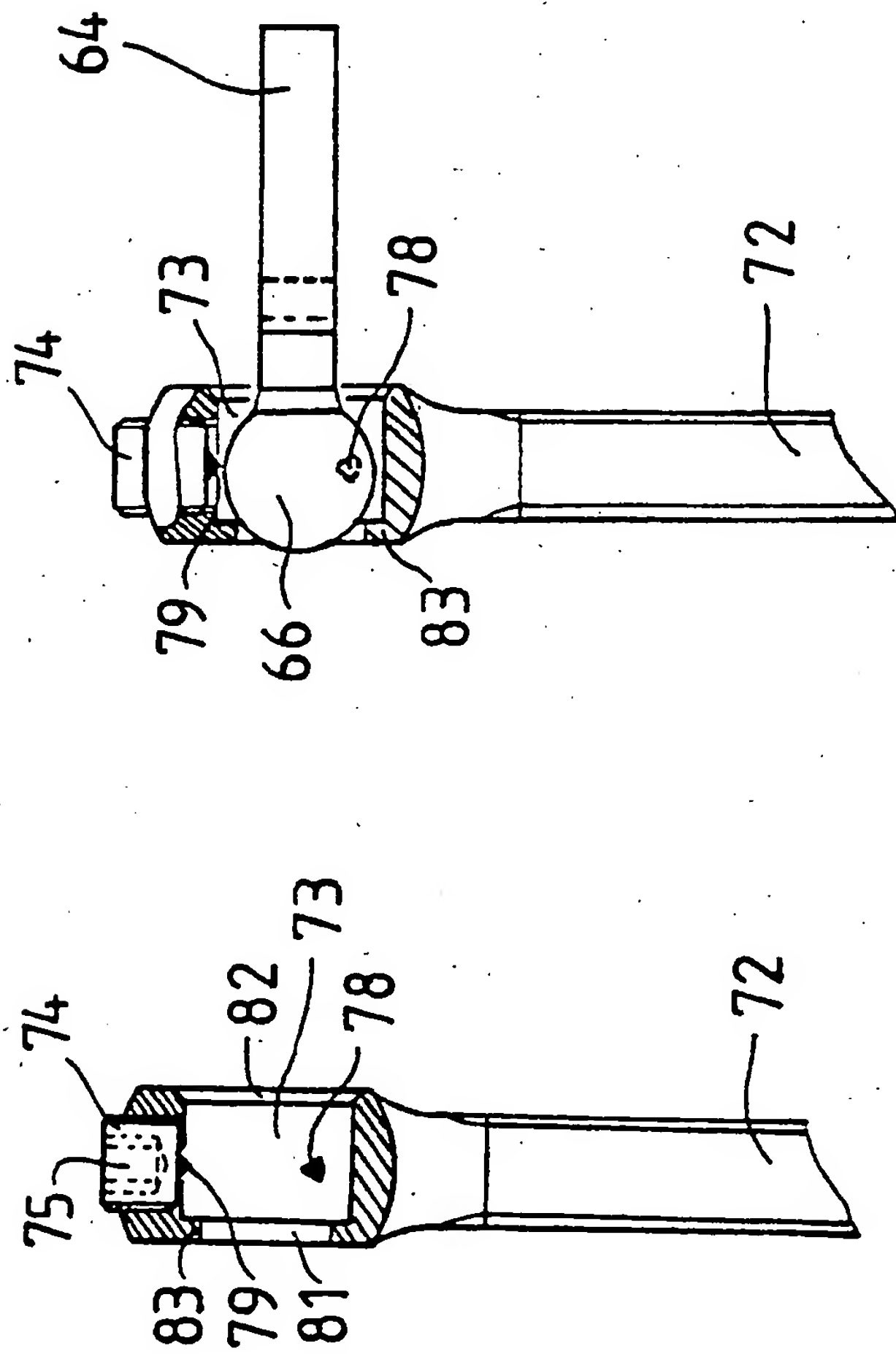


Fig. 17

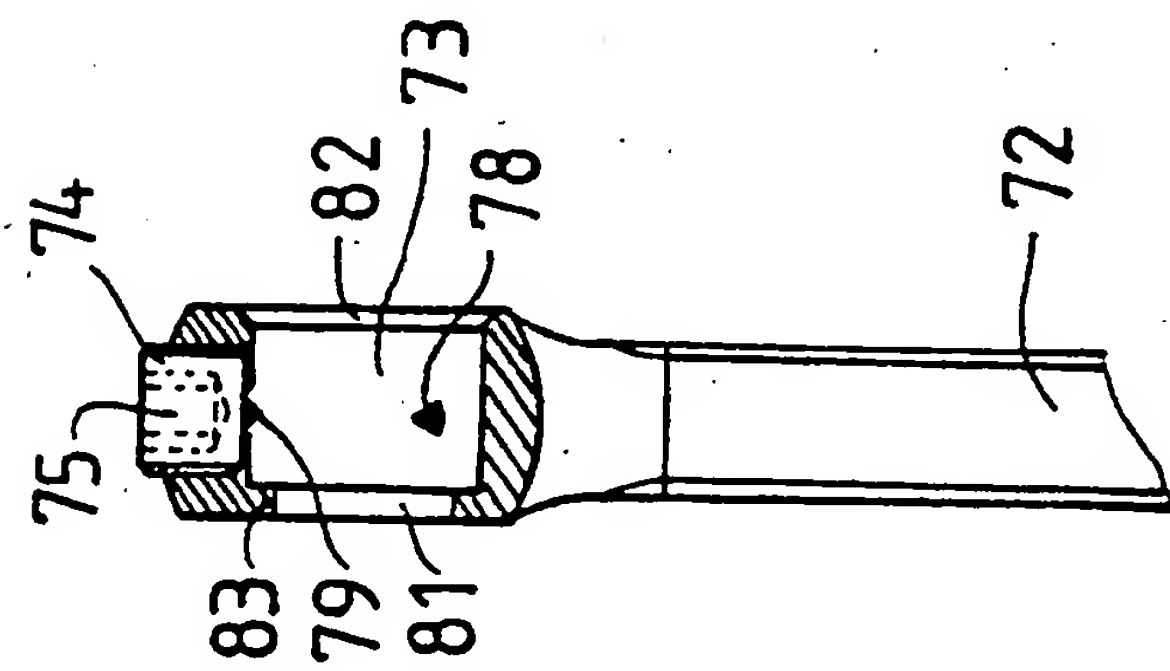


Fig. 16

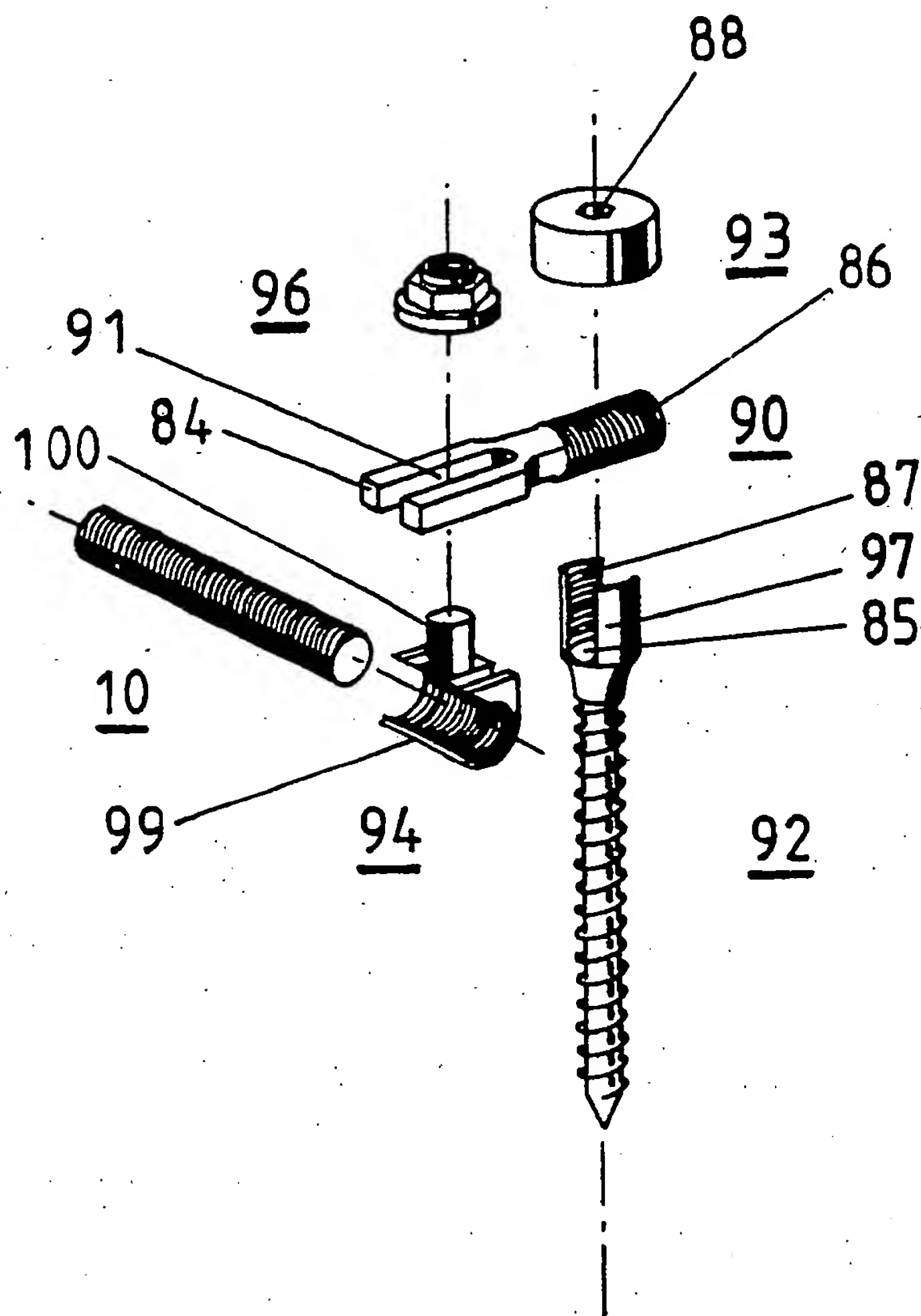


Fig. 19

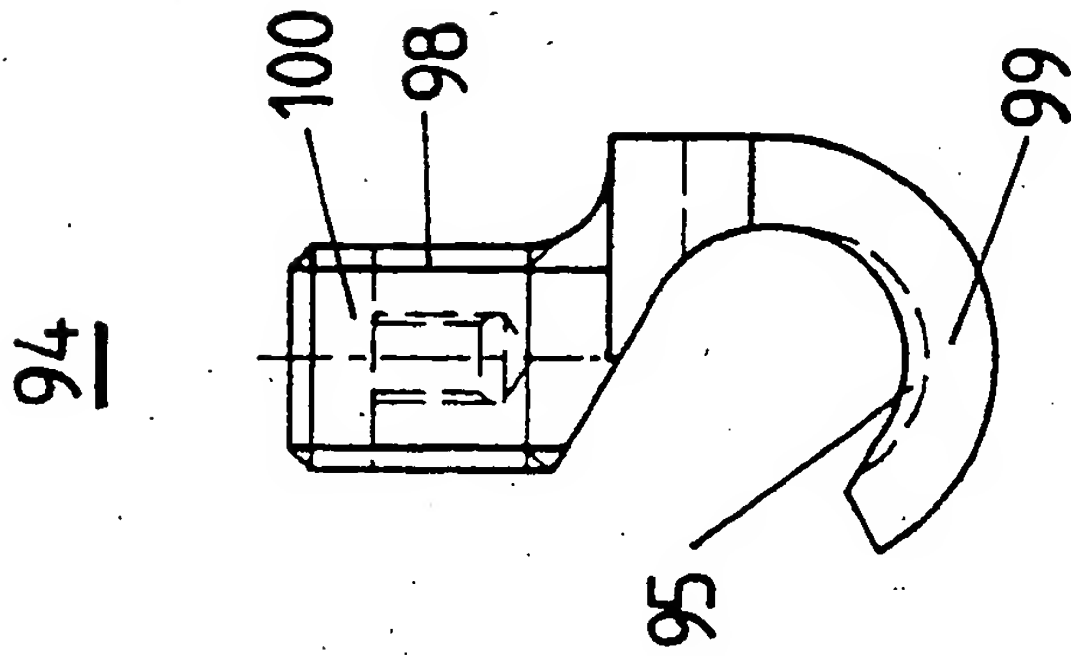
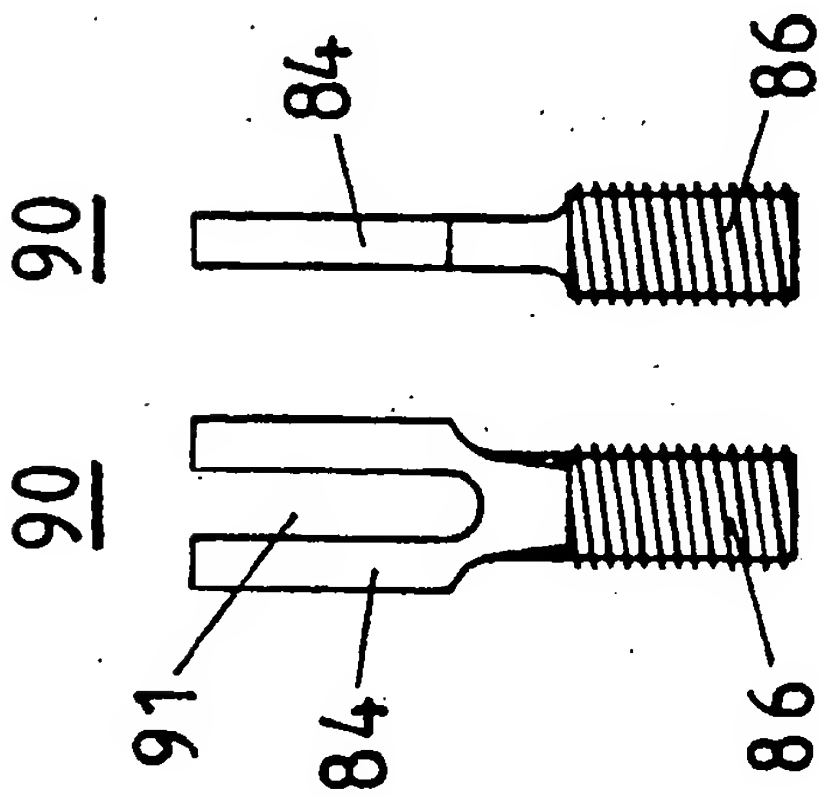


Fig. 20 Fig. 21 Fig. 22

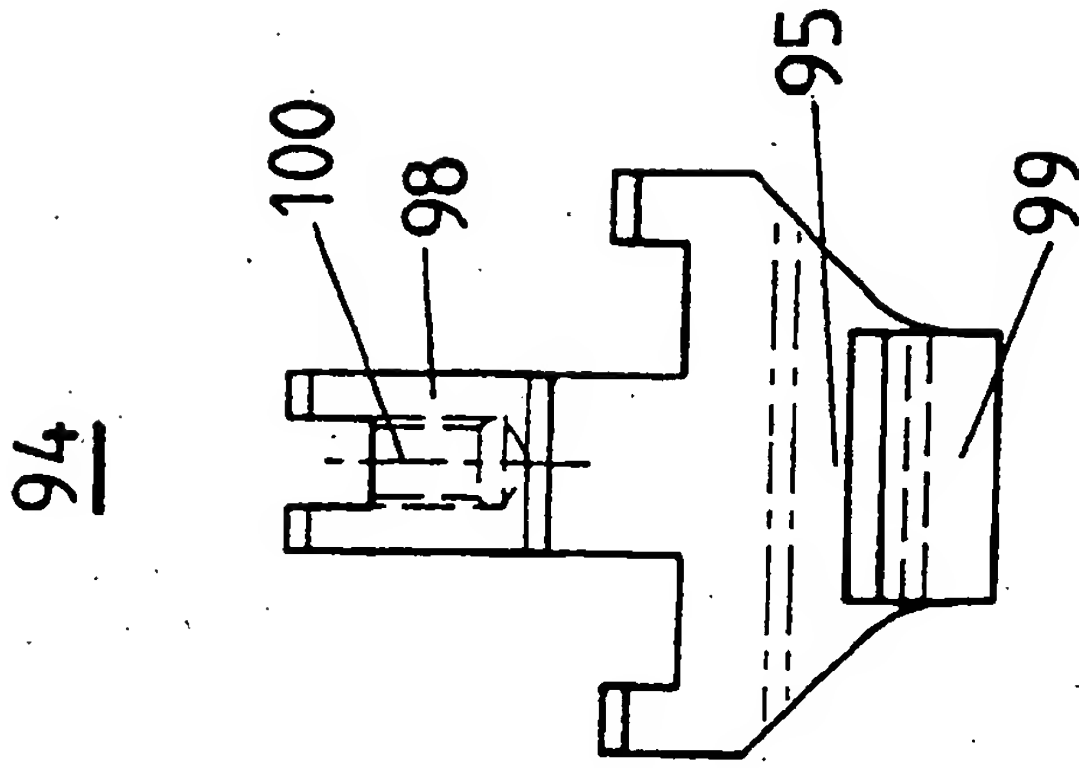


Fig. 23

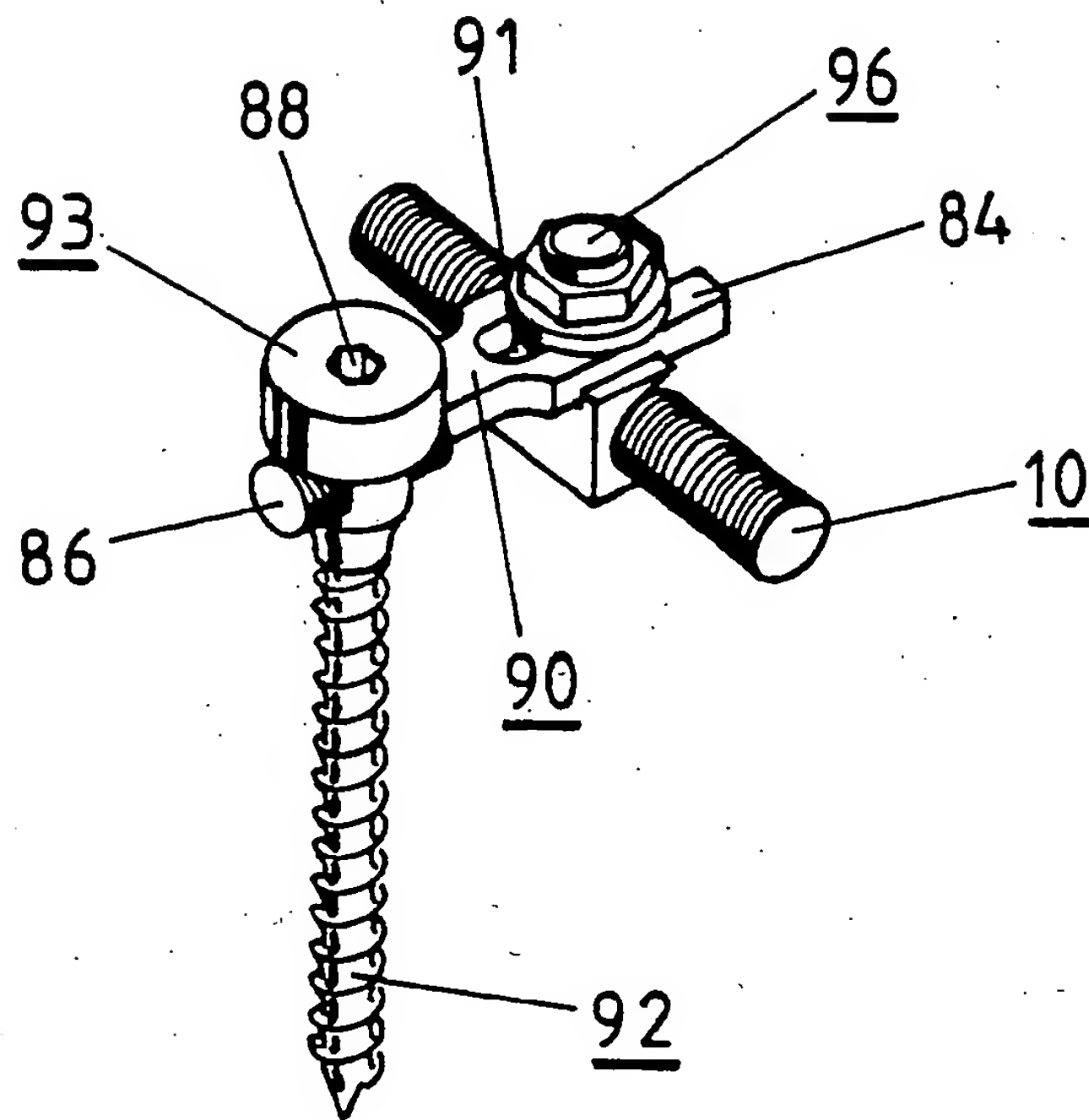


Fig. 24



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number

DOCUMENTS CONSIDERED TO BE RELEVANT			EP 90116070.5												
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. CL 5)												
X	EP - A2 - 0 242 708 (J. HARMS et al.) * Totality; especially fig. 4 *	1, 17, 18	A 61 B 17/56 A 61 F 2/44												
A		2-5, 10, 15, 16													
X	DE - B2 - 2 834 891 (SYNTHE AG) * Totality; especially fig. 1, 2, 4, 5 *	1, 17													
A		15													
A	US - A - 4 771 767 (A.D. STEFFEE) * Totality; especially fig. 7-9 *	1, 17													
A	US - A - 4 433 676 (K.A. BOBECHKO) * Fig. 1-7; abstract; column 2, lines 42-47; column 4, lines 49-54; column 5, lines 11-18 *	1	TECHNICAL FIELDS SEARCHED (Int. CL 5) A 61 B A 61 F												
A	FR - A1 - 2 615 095 (SOC. DE FABR. MAT. ORTH.) * Fig. 2-5; abstract *	1, 17, 18													
D, A	EP - A1 - 0 330 881 (SYNTHE AG) * Fig. 1-3, 6; abstract *	1, 17													
The present search report has been drawn up for all claims															
Place of search VIENNA		Date of completion of the search 12-02-1991	Examiner LUDWIG												
<table border="0"><tr><td>CATEGORY OF CITED DOCUMENTS</td><td></td></tr><tr><td>X : particularly relevant if taken alone</td><td>I : theory or principle underlying the invention</td></tr><tr><td>Y : particularly relevant if combined with another document of the same category</td><td>E : earlier patent document, but published on, or after the filing date</td></tr><tr><td>A : technological background</td><td>D : document cited in the application</td></tr><tr><td>O : non-written disclosure</td><td>L : document cited for other reasons</td></tr><tr><td>P : intermediate document</td><td>& : member of the same patent family, corresponding document</td></tr></table>				CATEGORY OF CITED DOCUMENTS		X : particularly relevant if taken alone	I : theory or principle underlying the invention	Y : particularly relevant if combined with another document of the same category	E : earlier patent document, but published on, or after the filing date	A : technological background	D : document cited in the application	O : non-written disclosure	L : document cited for other reasons	P : intermediate document	& : member of the same patent family, corresponding document
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